Research Report 1438

Grouped Versus Individualized Computer-Based Instruction (CBI) Training for Military Communications

Theodore M. Shlechter

Army Research Institute

ARI Field Unit at Fort Knox, Kentucky

Training Research Laboratory

U.S. Army

Research Institute for the Behavioral and Social Sciences

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A series of studies that investigated the effectiveness of a computer-based instruction (CBI) courseware for training Military Communications to 19K BNCOC (Basic Noncommissioned Officer's Course) students was conducted at the Army Research Institute's Fort Knox Field Unit. This investigation also examined the instructional potentials of packed or grouped (i.e., several students at a terminal) versus individualized CBI training. Sixty-nine soldiers (NCOs, E4 to E6) participated in three studies in which CBI training was provided in Military Communications. Studies 1 and 2 involved examining differences in soldiers' learning on a BNCOC performance test as a function of the CBI courseware and as a function of grouped versus individualized CBI training. The third study examined the viability of having the BNCOC instructors implement this courseware and the viability of using group CBI training in a regular 19K BNCOC class. This investigation's findings have shown that this CBI courseware is effective for training 19K BNCOC students in Military Communications and that grouped CBI training appears to be preferable to individualized CBI training for this courseware.

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Theodore M. Shlecter

ARI Field Unit at Fort Knox, Kentucky
Donald S. Haggard, Chief

Training Research Laboratory
Jack H. Hiller, Director

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

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FOREWORD

A major challenge to the modern Army is to provide more effective training while using fewer instructional resources. This research effort evaluated the effectiveness of computer-based instruction (CBI) courseware for 19K BNCOC training in Military Communications. This research effort also examined the feasibility of packing several students (i.e., putting two or more students at a single terminal) because of the cost problems and scheduling constraints with individualized CBI training.

This research effort was part of the Fort Knox Field Unit's research program to apply new training technology to armor skill training needs. A Memorandum of Agreement covering the application of training technology to armor skills training, was signed by the US Army Armor Center, the US Army Training and Doctrine Command (TRADOC) and the US Army Research Institute (ARI) on 4 Nov 1983. Results from this evaluation were briefed to the Technical Director of the US Armor School and TRADOC's Deputy Chief of Staff for Training. Based upon this investigation's findings, plans have been made by the US Armor School to implement this courseware into the 19K BNCOC course. This report also contains information that will be useful to military and civilian personnel engaged in the development and implementation of CBI.

EDGAR M. JOHNSON
Technical Director

GROUPED VS. INDIVIDUALIZED COMPUTER-BASED INSTRUCTION (CBI) TRAINING FOR MILITARY COMMUNICATIONS

EXECUTIVE SUMMARY

Requirement:

A major challenge to the modern Army is to provide more effective training while using fewer instructional resources. Analyses by the Fort Knox Training Technology Field Activity (TTFA) of the 19K Basic Noncommissioned Officer's Course (BNCOC) offered at Fort Knox identified a need to develop computer-based instruction (CBI) courseware for 19K BNCOC training in Military Communications. Evidence was also needed on the feasibility of packing several students (i.e., putting several students at a single terminal) at CBI terminals because of cost problems and scheduling constraints with individualized CBI training.

Procedure:

CBI courseware was developed to train Military Communications to 19K BNCOC students at the U.S. Army Armor School. This investigation consisted of three studies in which 69 soldiers were provided CBI training in Military Communications. Studies 1 and 2 involved examining the differences in subjects' pretest and posttest scores as a function of individual vs. grouped CBI training. Differences in students' needs for assistance while completing this courseware were also examined. The third study examined the viability of implementing this courseware and implementing group CBI training in 19K BNCOC.

Findings:

The CBI courseware was effective for training 19K BNCOC students in Military Communications. Results have also indicated that group presentation of CBI materials is more cost-efficient than individualized CBI training. More students will be able to receive CBI training with some increments in their learning efficiency. The grouped CBI students also needed substantially less guidance from the instructor than did the subjects' receiving individualized CBI training.

Utilization of Findings:

Based on this investigation, plans have been made by the U.S. Army Armor School to implement this courseware into the 19K BNCOC course. This report also contains information that will be useful to military and civilian personnel engaged in the development and implementation of CBI.

GROUPED VS. INDIVIDUALIZED COMPUTER-BASED INSTRUCTION (CBI) TRAINING FOR MILITARY COMMUNICATIONS

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INTRODUCTION

A major challenge to the modern Army is to provide more effective training while using fewer instructional resources. This challenge emphasizes the need to exploit more fully available training technologies. To meet this need, the Army Training and Doctrine Command (TRADOC), the United States Army Armor Center (USAARMC), and the Army Research Institute (ARI) have established a joint Training Technology Field Activity (TTFA) at Fort Knox. The mission of this TTFA is to identify, develop, and implement a variety of new technology-based training methods. The initial efforts of the Fort Knox TTFA focus on the MOS 19K Basic Non-Commissioned Officer Course (BNCOC) for training M1 tank commanders (TCs). Successful training innovations will be transferred to other Army training programs.

Analyses by the Fort Knox TTFA of the 19K BNCOC course have identified a need to develop new technology-based training methods for the "Communications-Electronics Operation Instructions" (CEOI) tasks. CEOI is a system developed by the US Army to ensure the reliability and security of tactical communications. The CEOI provides information about the proper codes for call signs, radio frequencies, authentication challenges and replies, and encoding/decoding messages. All CEOI extracts are standard in format but each unit's extract is unique in content. Since units on the modern battlefield will be widely dispersed, highly mobile, and operating semi-independently, the need for effective CEOI use is critical.

Current CEOI training has not produced the desired student performance on the BNCOC performance test. During FY 84/85, only 53% of the students performed successfully on the CEOI performance test. This CEOI test performance may be due to BNCOC students' being provided with only a few opportunities to practice using the CEOI. Limited CEOI practice appears to be the result of dwindling BNCOC instructor resources and compressed time for training.

A decision was made by Fort Knox's TTFA to develop Computer-Based Instruction (CBI) courseware for CEOI. This decision was based upon a belief that students could get the needed practice via CBI when instructional resources or time were low (see Department of Defense (DoD) Memorandum from the Assistant Secretary of Defense, 9 September 1985). Orlansky (1985) has suggested that CBI can also provide the means to develop standardized and accountable instruction across the full range of military training environments. Orlansky has also noted that CBI is particularly applicable to training military personnel in such areas as electronics, maintenance, and military communications.

A major obstacle for CBI implementation is the extensive costs associated with acquiring and operating CBI materials. Hardware costs for the CBI system used in this investigation--MicroTICCIT II System (Microcomputer Time-Shared Interactive Computer-Controlled Information Television)--were approximately $250,000 for a ten-terminal system. These costs do not reflect expenditures for producing courseware materials nor for classroom personnel. CBI operating costs per student contact hour have been estimated to range from

$2.00 to $10.94 per terminal (Avner, 1982; and Okey & Majer, 1976). The $2.00 figure represents nearly continuous and daily use of the system while the $10.94 figure represents sporadic CBI use. Though the hourly costs for a MicroTICCIT system have not been determined, its costs should parallel those previously cited for other CBI systems. The operating costs for a ten-terminal system should thus range from $20.00 to $100 per student contact hour. These hourly operating costs do not reflect the possible additional expenditures for updating the courseware. These costs may prohibit trainers from having enough terminals to accommodate individualized instruction. The Fort Knox TTFA had available only three work-station terminals for this investigation.

Critics of individualized CBI have noted several other problems with this mode of instruction. Morrison (in preparation) has suggested that class size and a limited number of terminals constrain students' use of CBI. For example, the current 19K BNCOC class size ranges from eight to sixteen students per cycle. The availability of only three terminals thus presents an obstacle to implementing CBI training in the 19K BNCOC course. The BNCOC instructors operating under tight scheduling constraints may not be able to schedule all students to receive individualized CBI training.

Clark and his associates (e.g., Clark, 1985; Clark & Leonard, 1985) found major problem with the cost effectiveness of individualized CBI training. After reviewing 42 randomly selected civilian CBI programs, Clark and Leonard have found that CBI as currently employed by teachers was most effective when supplemented by additional instruction. One example provided by Clark and Leonard was a study in which CBI students received the higher scores on an achievement test because these students received as much as eight minutes more drill-and-practice time than the conventional instruction groups received. The extent to which such additional instruction time is a problem depends, of course, on the observed amount of instruction to the amount intended by a system's designer. But, the need for special instructor prompting undermines CBI's promise to facilitate learning in situations with dwindling instructional resources.

There is also considerable evidence which suggests that working cooperatively in a group is more effective than working individually for a wide variety of tasks (Hagman & Hayes, 1986). They found, for example, that cooperative learning was an effective method for training students in an Army Quartermaster Course to use the Prescribed Load List (PLL) Manual. Also, cooperative learning seems to reduce a slow student's dependence on the instructor as other students serve as peer instructors. BNCOC instructors commonly use peer instructors when some students have indicated a mastery of the particular subject matter.

Packing several students at a terminal (i.e., putting two or more students at a single terminal) may be the most appropriate method for computer-based training on CEOI. For one thing, CEOI is a procedural task similar to the PLL task. And, peer instruction can be used as some students have had previous experience with operating the CEOI in their units. Packing students at terminals may also reduce the problems with costs and scheduling constraints cited for individualized CBI training. Group CBI presentation would

enable the 19K BNCOC students to conveniently and economically receive CEOI training. For these last two reasons, evidence is thus needed about the feasibility of packing students at CBI terminals.

Only a few previous studies (e.g., Dorsett & Hulverson, 1983; Okey & Majer, 1976; Sutter & Reid, 1969; and Trowbridge & Durnin, 1984) have actually compared grouped vs. individualized CBI training. Dorsett and Hulverson (1983) examined the effects of peer training via CBI in a military course on electronics. Seventy-two students received CBI peer-training; fifty-five students received individualized CBI training; and fifty-five received conventional instruction. The peer-training condition involved having two students with differing abilities working at the terminal. Scores on the performance test were nearly the same for students in the different conditions. Training time was significantly lower and less variable for the peer-training CBI students than for the students in the individualized CBI training condition. This latter finding is important because cost-efficiency for military training has included obtaining similar achievement levels while reducing time in training (Orlansky, 1985). Group CBI training appears then to be more cost-efficient than individualized CBI training. However, this study may have been confounded by the fact that discussion and interaction between pairs were encouraged and by possible demographic differences among the groups. Other problems with Dorsett and Hulverson's research is that they did not report any pretest results nor any differences in the groups' need for additional instructor prompting.

Okey and Majer (1976) also failed to find any differences in the test performance of student's receiving group or individualized CBI training. This study consisted of sixty college students receiving CBI training on elementary school teaching methods with 20 students in each of the following conditions--three/four per terminal; two per terminal; and one per terminal. Okey and Majer found that the three/four per terminal groups completed the training faster and with less variability in their training times than did students in the other conditions. However, information again was not provided about the different groups' pretest scores, demographic composition, and need for additional instruction.

The present investigation was designed to provide further data about the feasibility of packing several students at a CBI terminal. Such a group presentation of CBI materials was expected to alleviate the cited problems with using CBI as a primary instructional medium for military training. The present investigation was also designed to examine the effectiveness of a CBI course for CEOI training. This course was expected to be an effective method for training 19K BNCOC students to use the CEOI.

STUDY 1

Participants

Thirty-three armor noncommissioned officers stationed at Fort Knox, KY participated in this study. All participants were experienced soldiers in pay grades E4 to E6 and most of them had previous experience with tanks and the CEOI. Nearly all the participants had completed a high-school education.

Eight of these soldiers participated in the pilot study. The developmental trials (testing the courseware with ARI research personnel controlling the classroom) consisted of 25. Thirteen of these soldiers participated in the group condition (five or four per terminal) and twelve soldiers were in the individualized instructional condition. The pilot study and group condition soldiers were from the 19K BNCOC class. The individualized instructional condition soldiers were from an operational armor unit. Previous experience with soldiers from this unit suggested that their performance would be similar to the performance of the BNCOC students.

Equipment and Materials

A MicroTICCIT System II was used in this assessment. As previously stated, this system consisted of a host terminal and three work-station terminals. The host terminal was used for programming and processing the courseware and software while the students viewed the courseware at the work-stations. Wilson (1984) has described the MicroTICCIT system as "State-of-the-Art" technology with a work-station consisting of an IBM personal computer, a Sony color monitor, and a high speed communications link to the host terminal. Flicker-free presentation of computer-generated text and graphics (e.g. CEOI pages) as well as videotaped materials can be viewed on a terminal's visual display. Wilson has thus suggested that MicroTICCIT is a most powerful and cost-effective instructional delivery system. She has also indicated that MicroTICCIT's attributes allow courseware authors to have unprecedented freedom in developing and updating materials especially suited for a particular training problem. Graham, Shlechter, and Goldberg (1986) have found MicroTICCIT to be an effective instructional medium for Army maintenance training.

The CEOI courseware developed for this training program consisted of five main units. Unit I provided an overview of the course and the CEOI. The next four units provided students with instruction and practice on: 1) locating call-signs and suffixes; 2) locating radio frequencies of designated units; 3) encoding and decoding messages in standard military terminology; and 4) finding the proper reply authentication code for any randomly generated two-letter challenge code. Each section consisted of textual information and practical exercises. This courseware was developed by contractors.

The courseware also included a pretest and a posttest. These two tests consisted of eight different items for measuring the tasks embedded in the CEOI instruction. The computer posttest was not administered to the students because standard operating procedures required that the standard 19K performance exam for CEOI training be given to the 19K BNCOC students. This latter test is a paper-and-pencil assessment of the students' ability to master the different CEOI tasks. Shlechter and Anderson (1986) found the BNCOC performance test and the computer-embedded pretest to be comparable measures of CEOI performance.

A demographic questionnaire was designed to assess the subjects prior educational and relevant military experiences. The following issues were examined on this questionnaire:

a. years in PMOS.

b. years on tanks.

c. months as a Tank Commander (TC).

d. Primary Leadership Development Course training.

e. number of tactical training exercises within the last twelve months.

f. any previous CEOI experience.

g. highest educational level.

Previous experience with 19K BNCOC students had suggested that these demographic variables might effect the soldiers' performance.

Procedure

A pilot study was conducted to examine possible problems with the courseware and evaluation instruments. The eight pilot soldiers were presented the courseware with two to three students per terminal. Terminal assignments were based upon the BNCOC instructors' assessment of their students' CEOI abilities with each terminal group having the same proportion of high and low ability students.

Trained observers recorded the following information while the soldiers' completing the CEOI lessons: 1) frequency of responses (providing the answer to the computer exercises from the CEOI); 2) frequency of help requested; 3) frequency of helping behavior; 4) frequency of proctor prompting; and 5) time to complete the CEOI lessons. Information for categories 1-4 were recorded for both individual soldier and for each terminal group, e.g., a group response to the instructional materials. Time in completing the instructional materials was recorded for each terminal group. The time that the soldiers spent completing the tests and taking breaks was not included in these observations. Students were given ten minute breaks after each fifty minutes of instruction. Observers were also instructed to refrain from helping and interfering with the subjects. Students were thus neither encouraged nor discouraged from discussing the CBI materials.

As indicated, a proctor (a civilian ARI employee knowledgeable in the CEOI tasks) was available to help the students in understanding and completing the instructional materials. This help was only to be given when requested by the soldiers. The BNCOC instructors were also told to refrain from providing any assistance to the students. These instructions for the proctor and BNCOC instructors were also repeated for the developmental trials. The BNCOC instructors did not participate in the administration of any computer materials.

The pilot study's results demonstrated that some revisions in the courseware and experimental procedures were needed. Courseware revisions involved fine tuning the practical exercises to make them as accurate and realistic as possible with regards to military situations. Experimental procedure revisions involved fine tuning the observational sheets and providing students

with five minute breaks after each twenty-five minutes of instruction. Otherwise, the procedure for the developmental trials was the same as the pilot study's.

The procedure for the developmental trials also included group administration of the demographic questionnaire and the computer embedded pretest. Each soldier, who was carefully watched by an observer, individually completed the pretest items. After taking the pretest, the grouped condition students were then assigned to terminals. Each terminal had basically the same proportion of soldiers receiving high (high CEOI ability soldiers), medium (medium CEOI ability soldiers), and low (low CEOI ability soldiers) scores. The individual group soldiers were also administered the computer embedded pretest by an observer. Practical constraints prevented group administering the pretest to these soldiers. All soldiers were provided feedback regarding their pretest scores after completing the posttest.

The soldiers, regardless of experimental condition, individually completed the posttest upon finishing the CBI courseware. BNCOC standard operating procedures required that the BNCOC instructors administer the posttest to their students. Soldiers in the group condition were given the posttest by the BNCOC instructors while the civilian proctor administered the posttest to the individual condition soldiers. Because of BNCOC operating procedures the soldiers from the armor unit which was presented an alternative form of the posttest presented to the BNCOC students. Table 1 shows the types of tests taken by the participants in the different research conditions. These two posttests were comparable measures of students' CEOI performance (Shlechter & Anderson, 1986). All other procedures for administering this test were the same for all soldiers. These tests were then scored by the proctor based upon a predetermined scoring scheme.

Table 1: Types of Pretests and Posttests Taken by the Different Research Conditions

	Computer-Embedded Pretest	Hard-Copy Pretest
Old BNCOC* Posttest	Study 1's Individualized Training Soldiers	Study 2's Soldiers
Alternative Form of Old BNCOC Posttest	Study 1's Grouped Training Soldiers	
New BNCOC Posttest		Study 3's Soldiers

*BNCOC Posttests were paper-and-pencil measures.

Results and Discussion

The standard criterion measure for CEOI training is receiving a GO (passing score) on the performance test. Passing involves mastering all of the six CEOI tasks embedded in the test -- 1) finding your unit's call sign; 2)

finding another unit's call sign and radio frequency; 3) sending an initial statement to another unit; 4) replying to an authentication request; 5) decoding a received message; and 6) encoding a message to transmit. The same percentage of soldiers passed the pretest from both research groups. Fifteen percent of the group condition students and zero percent of the individual condition received GOs on the pretest. Seventy-seven percent and twenty-five percent of the soldiers in the group and individualized instruction conditions, respectively, passed the posttest. These data are presented in Figures 1 and 2. Statistical analyses for this investigation can be found in the appendices.

These differences in the test performance may have been an artifact of prexisting differences between the two research conditions. A relationship was found to exist between the soldiers' posttest Go-rates and their previous CEOI use. As shown in Table 2, the grouped condition had the larger proportion of participants who were familiar with the CEOI.

Table 2: Study 1: Demographic Results

GROUPED CONDITION (n=13)		INDIVIDUALIZED INSTRUCTION CONDITION (n=12)
19K BNCOC	TYPE OF STUDENTS	ARMOR UNIT-19E/19K
2.26	AVERAGE NUMBER OF YEARS IN PMOS	2.67
5.38	AVERAGE NUMBER OF YEARS ON TANK	2.00
32.32	AVERAGE NUMBER OF YEARS AS TC	4.83
11	NUMBER OF SUBJECTS WITH PLDC EXPERIENCE	7.17
2.69	AVERAGE NUMBER OF TACTICAL TRAINING EXERCISES	7.00
10	NUMBER OF SUBJECTS WITH CEOI EXPERIENCE	2.00
	HIGHEST EDUCATIONAL LEVEL	
1	NON HIGH SCHOOL GRAD	0
5	GED	3
4	HIGH SCHOOL DIPLOMA	9
3	SOME COLLEGE	0
0	COLLEGE GRAD	0

The GO-rate measure may not provide the most precise index of students' CEOI learning. That is, one student receiving a GO on the posttest and not the pretest may have missed just one pretest item while another student with the same set of GO scores may have missed all the pretest items. An item-score measure was then created in which a student received a score of 1.5 for getting the item totally correct or the appropriate partial credit. Since each of the six test items consisted of several components (e.g., prefix, suffix, and radio frequency for the call-sign items), information about students' learning would be lost if such partial credit was not given and the 1.5 point scale was found to be appropriate for determining partial credit.

As indicated in Figure 3, noticeable differences between pretest and posttest item-scores were found for both groups. The averaged item-scores for all subjects were 5.44 and 7.64 on the pretest and posttest, respectively. This difference of 2.2 points represented a 24% increase of students' performance between the pretest and posttest (from a 60% pretest score to an 84% posttest score). These item-score differences indicated that this CEOI courseware did increase soldiers' proficiency with the CEOI.

Significant differences, however, were not found between groups with regards to item-score differences. The grouped condition students averaged 6.31 points and 8.46 points for the pretest and posttest, respectively, while the individual condition soldiers averaged 4.5 and 6.75 points for these two tests. The inability to find significant differences between the groups' item-scores might be attributable to a ceiling effect for the group condition soldiers. After all, these soldiers averaged 94% on the posttest with twelve of these thirteen soldiers getting eight or more total points.

The grouped condition soldiers completed the lessons nearly eight minutes faster (156 versus 163.67 minutes) than the individual condition soldiers. This eight minute time difference was not statistically meaningful. This lack of significance was due to the variability found in the individualized instruction soldiers' completion times (See Figure 4 for a pictorial presentation of these data). The courseware did reduce BNCOC students' CEOI training time with an average of 160 (2.5 hrs) minutes for the entire sample as opposed to the 210 minutes (3.5 hrs) they currently spend in CEOI training. These time results and the different learning performance data also suggested potential cost savings for group presentation of the CBI materials. More students can be instructed in the group mode without any decrements in learning efficiency.

The results also demonstrated a difference in the frequency of help provided by the proctor. The soldiers in the individualized instructional condition received eight times (72 incidences compared to 9 incidences) more help from the proctor than did the group soldiers. Correspondingly, the results indicated that the group soldiers received substantial help from each other in completing the task with 93 incidences of such helping behavior being recorded. The majority of this help, of course, was given by the top students serving as peer-instructors.

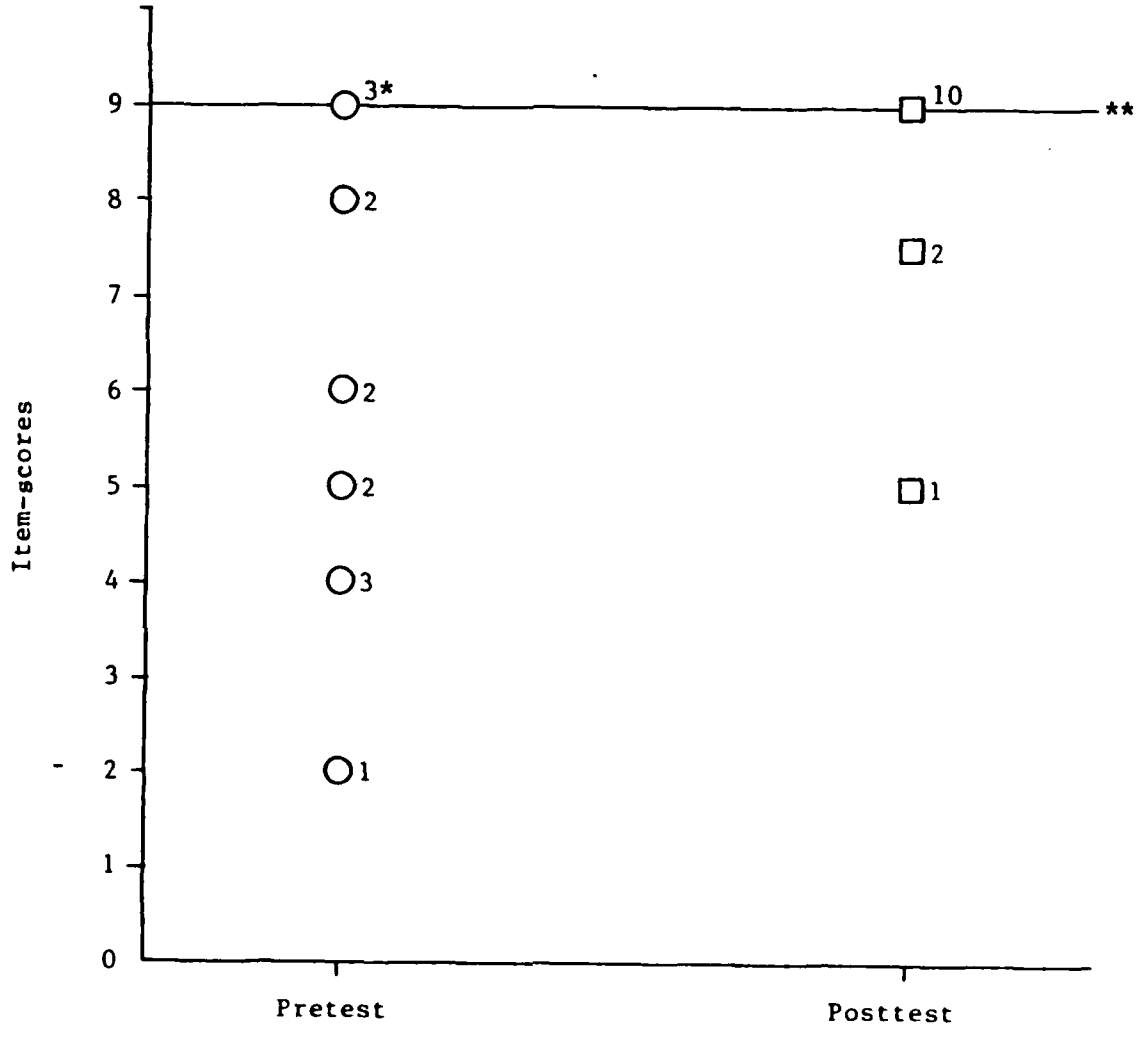

Figure 1. Study 1: Grouped Training Condition Soldiers' Item-Scores for the Pretest and Posttest (N=13).

*All numbers by symbols represent frequency for each item-score.

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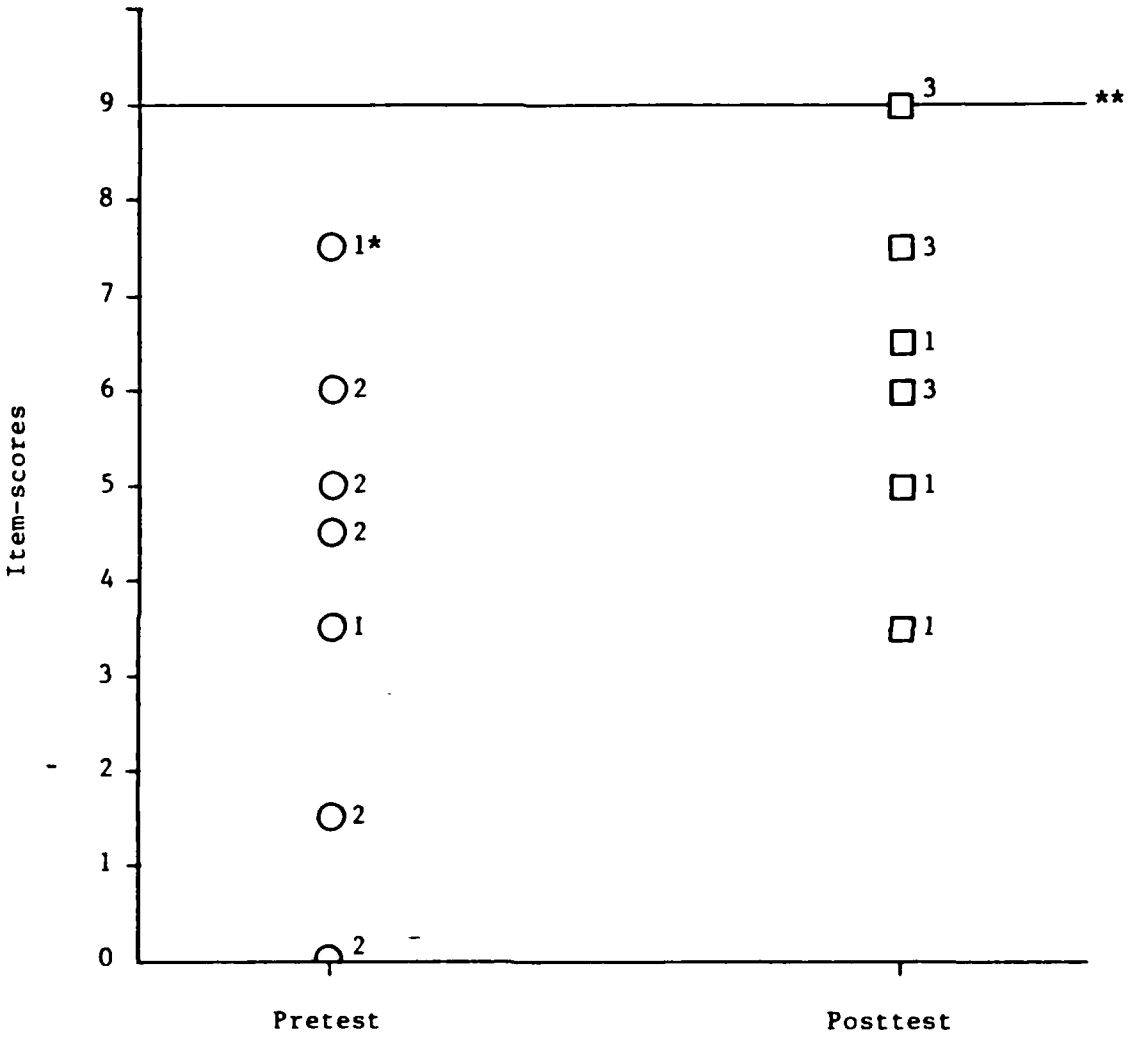

Figure 2. Study 1: Individualized Training Condition Soldiers' Item-Scores for the Pretest and Posttest (N=12).

*All numbers by symbols represent frequency for each item-score.

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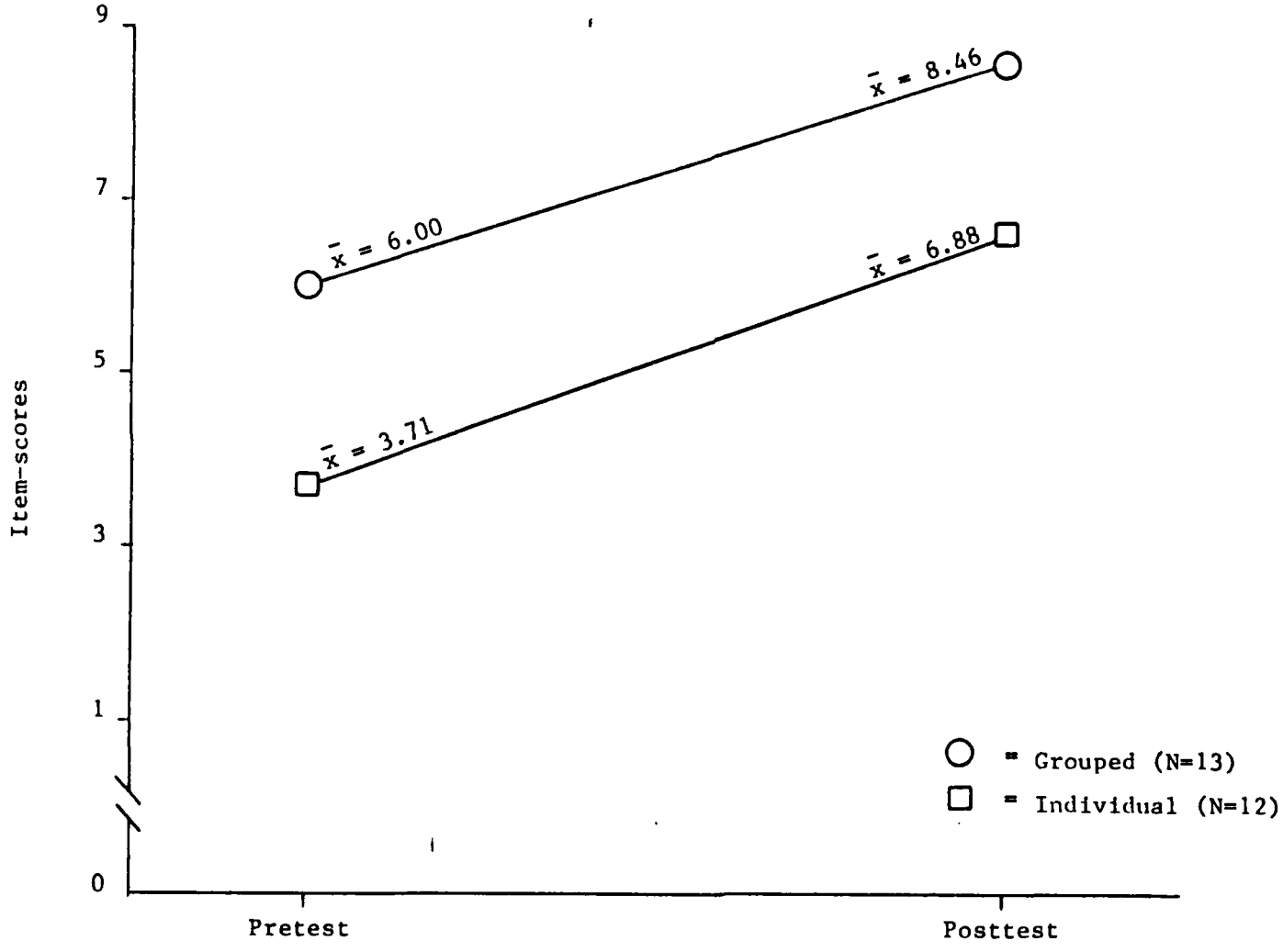

Figure 3. Study 1: Mean-Items Scores for Grouped and Individualized Training Conditions.

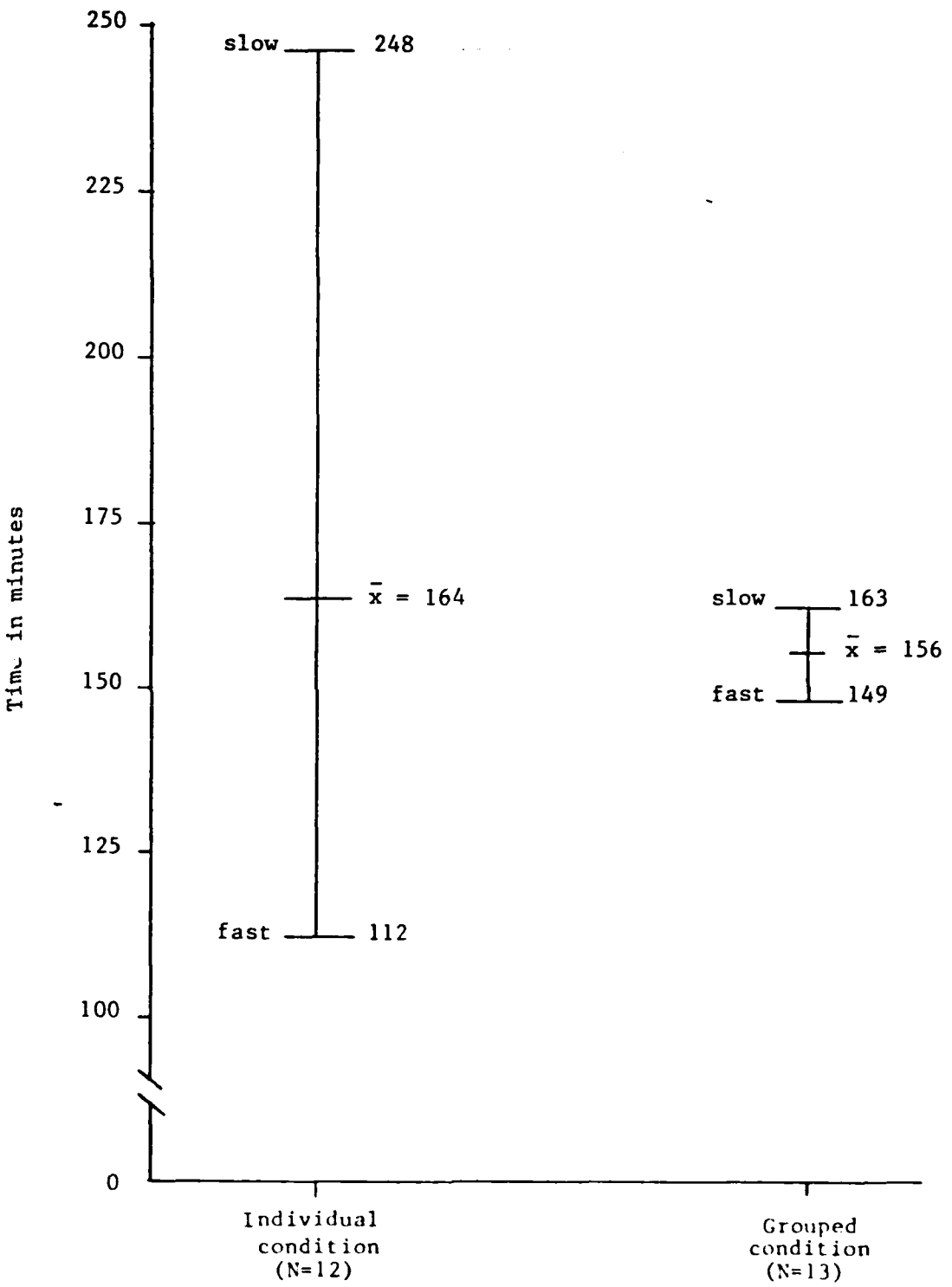

Figure 4. Study 1: Range of Time in Minutes to Complete Lessons by Conditions.

The results also showed that responses to the CBI materials in the different groups were not dominated by any one soldier and that approximately 40% of the responses were a group effort. However, slight differences were found in the dynamics of each group. For example, a group effort at one terminal consisted of each participant answering a part of the practical exercise while at another terminal a group effort involved discussing the item. All groups usually did reach a consensus before responding to the computer and if a member did not agree or understand the rationale for an answer then a discussion would ensue.

Seemingly, then, cooperative learning did occur with the grouped condition soldiers and this learning was not dependent upon guidance from the proctor. The individual condition soldiers seemed to be proctor dependent while completing this courseware. This latter conclusion is further supported by observers' comments indicating the proctor's importance in helping the individual condition students to complete certain segments of the CBI courseware. Group presentation may be an answer to the Army's problem of effectively presenting instructional materials despite dwindling instructional resources. Of course, firm conclusions on the differences between grouped and individualized CBI presentation based upon this study's results cannot be made. A replication of this study without the confounding due to the demographic differences must be conducted.

STUDY 2

Procedure

The following methodological changes were made in this study. All soldiers were from an operational armor unit. Correspondingly, then, the BNCOC instructors did not participate in this study. Secondly, four soldiers per terminal were in the grouped (packed) condition rather than four or five students per terminal. Thirdly, another experimental condition was added which included two students per terminal (paired condition). Thirty-six subjects (twelve per condition) thus participated in this study. Soldiers in the packed and paired conditions were assigned to terminals based upon their pretest scores with the same stipulations for terminal assignments as discussed for STUDY 1.

The paired condition was added to determine the optimal number of students which could be packed at a terminal. This condition was added to determine the optimal number of students which could be packed at a terminal. Several reports (Dickson & Vereen, 1983 and Dorsett & Hulverson, 1983) have suggested that two at a terminal is optimal for efficient instruction. Other reports (e.g., Okey & Majer, 1976) have indicated that having three or four students at a terminal is preferable to two or fewer students per terminal.

Another procedural change involved using a paper-and-pencil pretest which was a "hard-copy" form of the computer-embedded pretest. This paper-and-pencil test was created to control for the possibility that the discussed differences in pretest administrations did affect STUDY 1 soldiers' test performance. Practical constraints still prevented the individual administration of this pretest. As shown in Table 1, the posttest was the same test as the one presented to the armor unit soldiers in STUDY 1.

Results and Discussion

Several results obtained in this study paralleled those found in the first study. For one thing, only one soldier who was from the individualized instruction group passed the pretest. No differences were found among the students from the different research conditions with regards to passing the pretest. Secondly, differences were found among the conditions' posttest Go-rates. Fifty percent and 25 percent of the packed condition and paired condition soldiers passed the posttest. These data are found in Figures 5-7.

Unlike the first study, this shift in GO-rates between tests for the packed condition was not confounded by the soldiers' previous experience with using a CEOI. As shown in Table 3, these three conditions consisted of soldiers with similar military and educational backgrounds. And, relationships were not found between soldiers' test performances and the demographic variables. In fact, six of the nine subjects passing the posttest did not have any previous experience with using the CEOI. Packing students at terminals seemed then to be the most efficient of the three different CBI modes examined for helping students to master this courseware.

Table 3: Study 2: Demographic Results

TYPE OF STUDENTS	PACKED COND. (n=12) ARMOR UNIT	PAIRED COND. (n=12) ARMOR UNIT	INDIVIDUAL COND. (n=12) ARMOR UNIT
AVERAGE NUMBER OF YEARS IN PMOS	2.50	2.03	2.61
AVERAGE NUMBER OF YEARS ON TANKS	1.34	1.91	2.69
AVERAGE NUMBER OF MOS. AS TC	4.83	6.17	7.42
NUMBER OF Ss WITH PLDC EXPERIENCE	3	3	5
AVERAGE NUMBER OF TACTICAL TRAINING EXERCISES	1.58	.50	2.92
NUMBER OF Ss WITH CEOI EXPERIENCE	7	3	6
HIGHEST EDUCATIONAL LEVEL			
NON HIGH SCHOOL GRADUATES	0	0	0
GED	0	2	1
HIGH SCHOOL DIPLOMA	9	6	9
SOME COLLEGE	3	1	1
COLLEGE GRADUATES	0	1	1

However, as was found in Study 1, learning as measured by the item-score index was nearly the same for all three groups. Increases of 3.33 points or 33% were found for the individual condition students' item score performance and increases of 2.97 points or 33% were found for both the packed and paired condition students (see data in Figure 8). As found in Study 1, the statistical analysis revealed that these pretest and posttest differences were significant ($p<.05$). The CBI courseware thus seemed to have a significant impact upon CEOI learning. And, packed or paired presentation of CBI materials does not seem to augment nor diminish this medium's potential for training soldiers in Military Communications.

This study's data also provided further evidence that the packed condition students had an easier time in completing the computer lessons than did the individual condition students. As shown in Figure 9, the packed students completed these lessons in substantially less time than did the individual condition subjects. Even though tremendous variability existed in the individual condition soldiers' completion time, this time difference of over fifty minutes was statistically meaningful. The data also indicated that the packed condition soldiers made fewer wrong responses and needed less help and proctor assistance in completing these lessons than did the individual condition subjects (see table 4 on page 20). Packed presentation of CBI materials seems to be a more efficient mode than individual training for presenting computer courseware.

The packed condition soldiers' relative ease in completing these lessons again appeared to be due to the cooperative learning exhibited by these soldiers. As indicated in Table 4, these soldiers seemed to help each other in completing these lessons. And, a group effort was predominant for two of these groups with no individual member's dominating. As was the case in Study 1, frequent discussion among members was observed for these two groups. These students' need for help was thus reduced as the group further elaborated upon and digested the courseware.

The dynamics for the third group in the packed condition were radically different. One member did dominate this group by providing most of the answers and by controlling this group's limited discussion. Another problem with this group was that its member with the lowest pretest score (low ability student) only answered two questions. This student and another low ability student were frequently excluded from the group's discussions and were frequently observed not to be paying attention to the computer exercises. Cooperative learning did not occur in this group. Consequently, these two students with little previous CEOI expertise did not gain very much from this courseware.

The learning problems of these two low ability students in the packed conditions could explain the discrepancy found between the GO-rate and item-score data. As previously discussed, packing students at terminals was the optimal instructional mode for facilitating the most students to achieve criterion but was the same as the other instructional modes for facilitating overall CEOI learning. Perhaps, then, packing students at the CBI terminal was the optimal mode for training students with initially good or fair CEOI skills but not for training students with initially poor CEOI skills. The data also showed substantial improvement for nearly all the low ability students in the individual training condition. Their scores increased, except

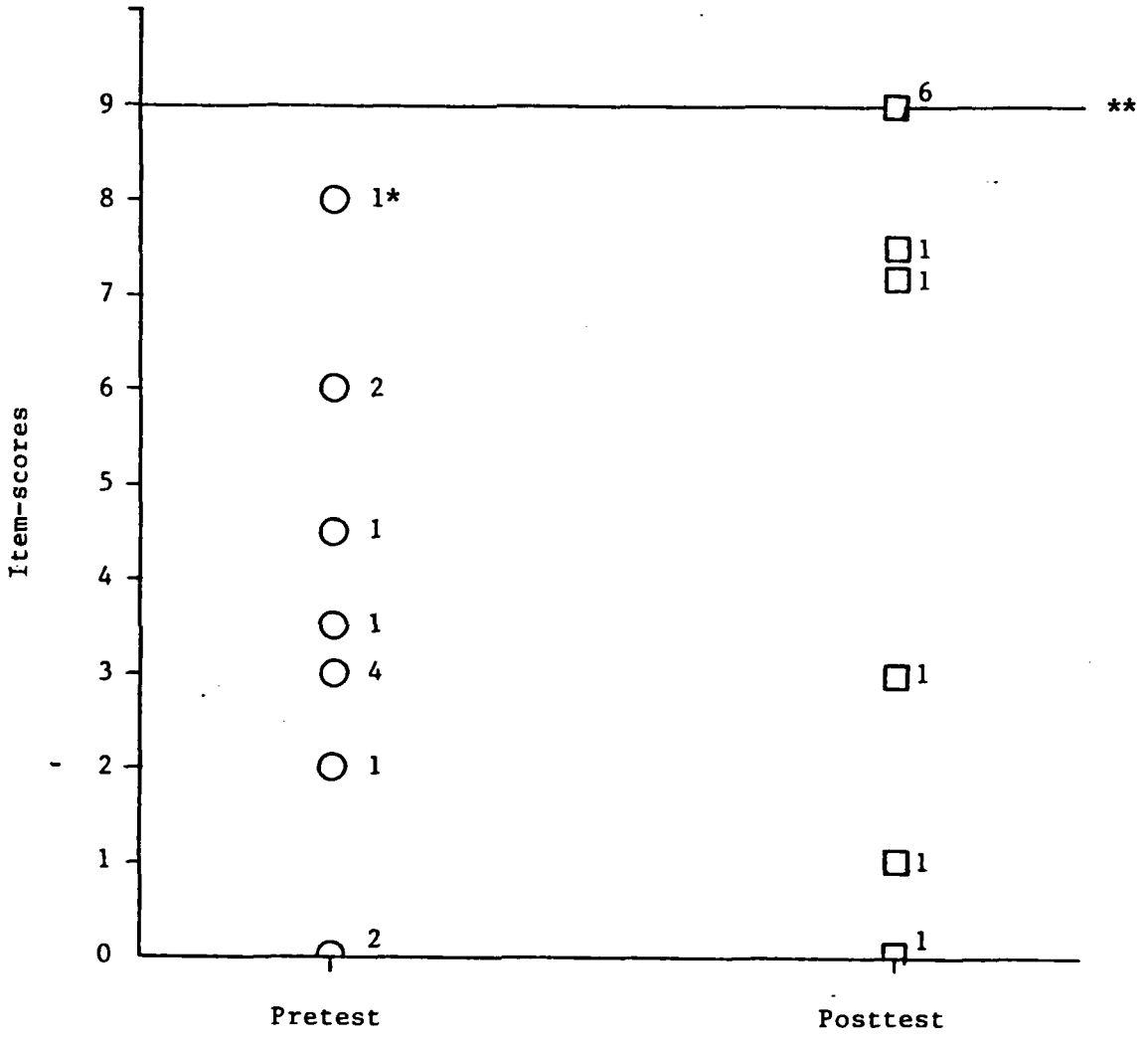

Figure 5. Study 2: Packed Training Condition Soldiers' Item-Scores for the Pretest and Posttest (N=12).

*All numbers by symbols represent frequency for each item-score.

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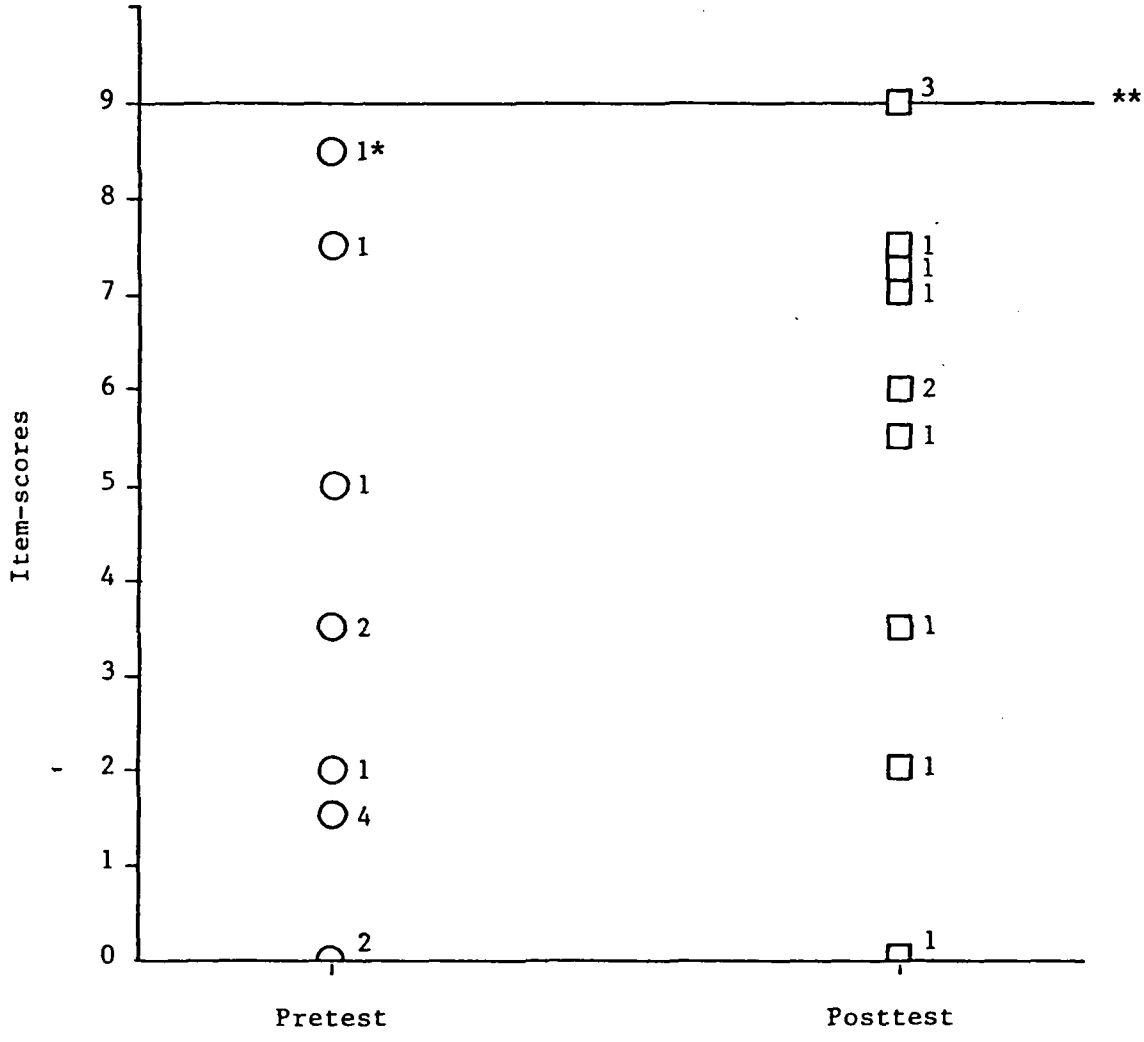

Figure 6. Study 2: Paired Training Condition Soldiers' Item-Scores for the Pretest and Posttest (N=12).

*All numbers by symbols represent frequency for each item-score.

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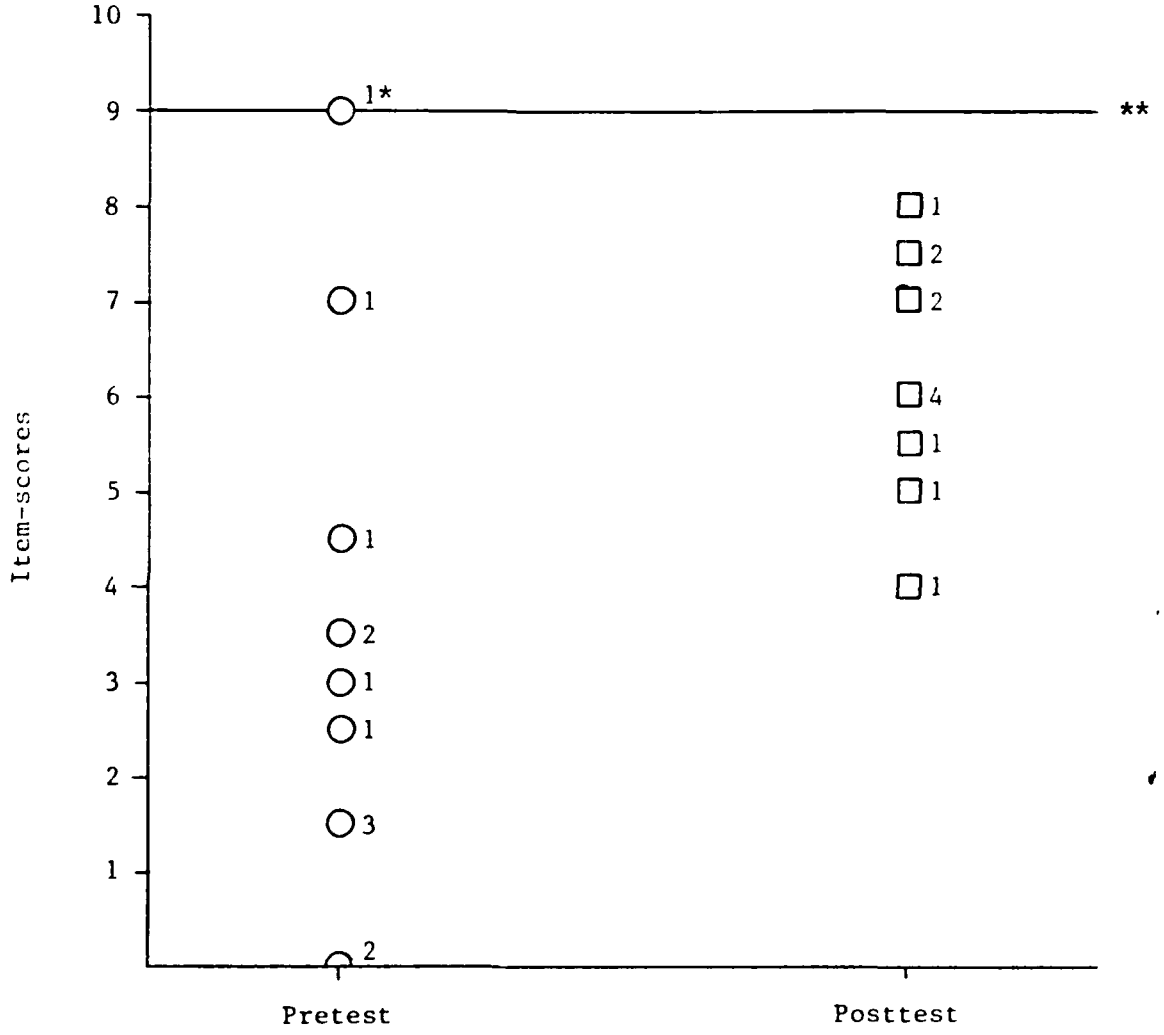

Figure 7. Study 2: Individual condition soldiers' item-scores on pretest and posttest (N=12).

*All numbers by symbols represent frequency for each item-score.

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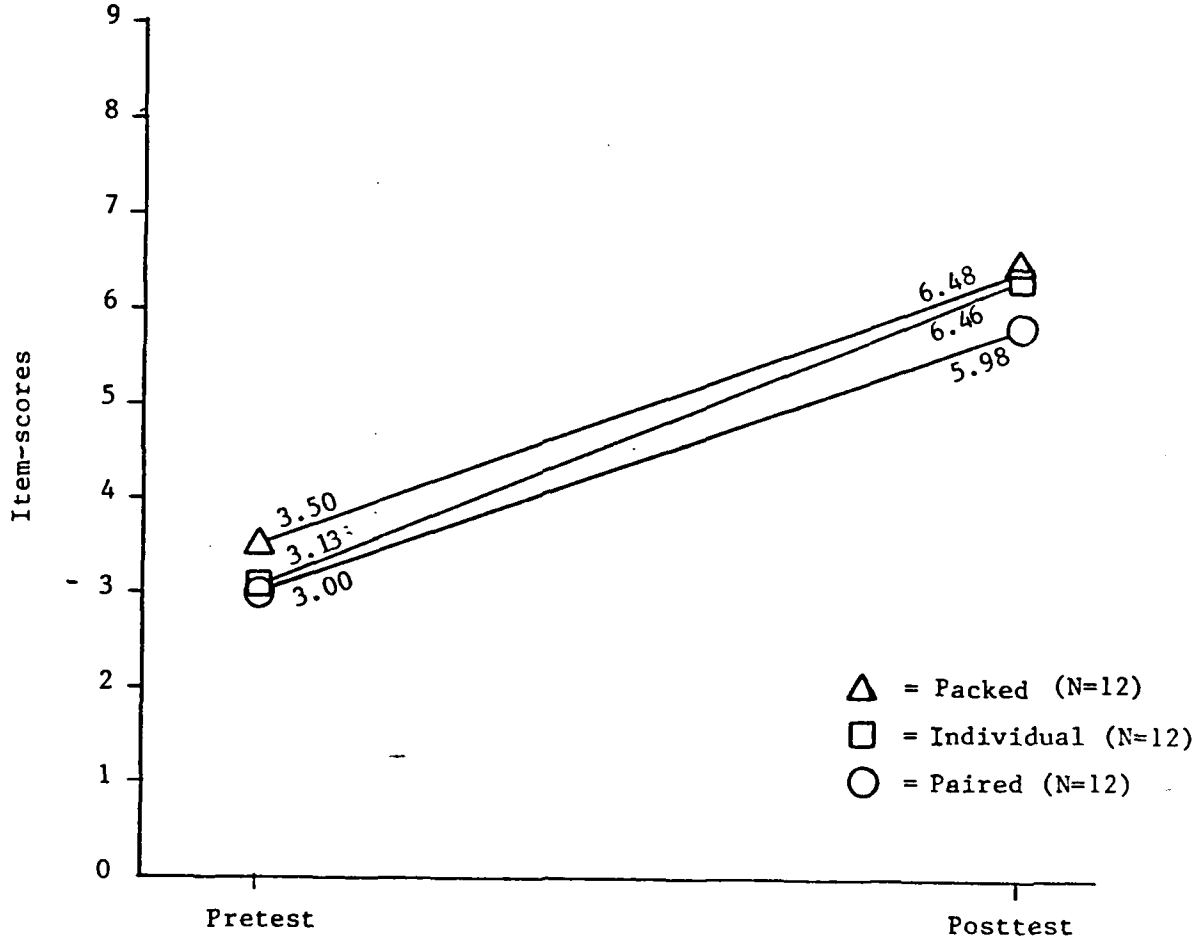

Figure 8. Study 2: Mean Item-Scores for Packed, Paired, and Individual Conditions.

for one subject, by around five to seven points. This improvement for low ability students was also found for study 1. Individualized CBI training may then be best for instructing students with initially deficient skills.

These differences between instructional modes for training low ability students might be an artifact of some extraneous treatment variables. For one thing, the two low ability students in the packed condition, who had the most problems learning the materials, were mainly found in the group with the unique dynamics. This experimenter later learned that the two dominant group members were buddies and the others were outsiders. Instructors should be aware of such possible problems before assigning students to terminals. Secondly, the individual condition students with the lowest pretest scores generally needed the most proctor assistance. The proctor rather than the CBI courseware could have been responsible for the learning exhibited bythese low ability students. Again, students in the packed and paired conditions rarely received proctor assistance. Future research in which students receive the CBI courseware without proctor assistance is needed to ascertain the relative value of individualized CBI training for low ability students.

With regards to the relative value of paired CBI training, the data (see Figure 5-7 and Table 4) have indicated several advantages for this instructional mode over the individual training mode. As previously stated, more of the paired condition soldiers achieved the posttest criterion. Also, these soldiers needed noticeably less assistance from the proctor and made noticeably fewer errors in completing the courseware than did the individual training subjects. However, meaningful differences between these conditions were not found for the "TIME" and "NEED HELP" variables. Perhaps, then, both groups had similar problems with this courseware but the discussions which occurred within the different paired groups helped these subjects to complete these lessons with fewer errors and less need for the proctor.

The only statistically meaningful differences found between the paired and packed subjects' performance were for the "TIME" and "NEED HELP" variables. One explanation of these differences is that the paired groups were controlled by the less advanced students while the packed condition moved at

Table 4: Study 2: Frequencies of "Proctor Assistance," "Need Help," and "Gave Help" by Conditions

VARIABLES	PACKED CONDITION*	PAIRED CONDITION	INDIVIDUAL CONDITION
PROCTOR ASSISTANCE*	0	27	115
WRONG RESPONSES	50	101	234
NEED HELP	44	136	123
GAVE HELP	51	99	0

*Tests for significant differences among groups performance are presented in Appendix B.

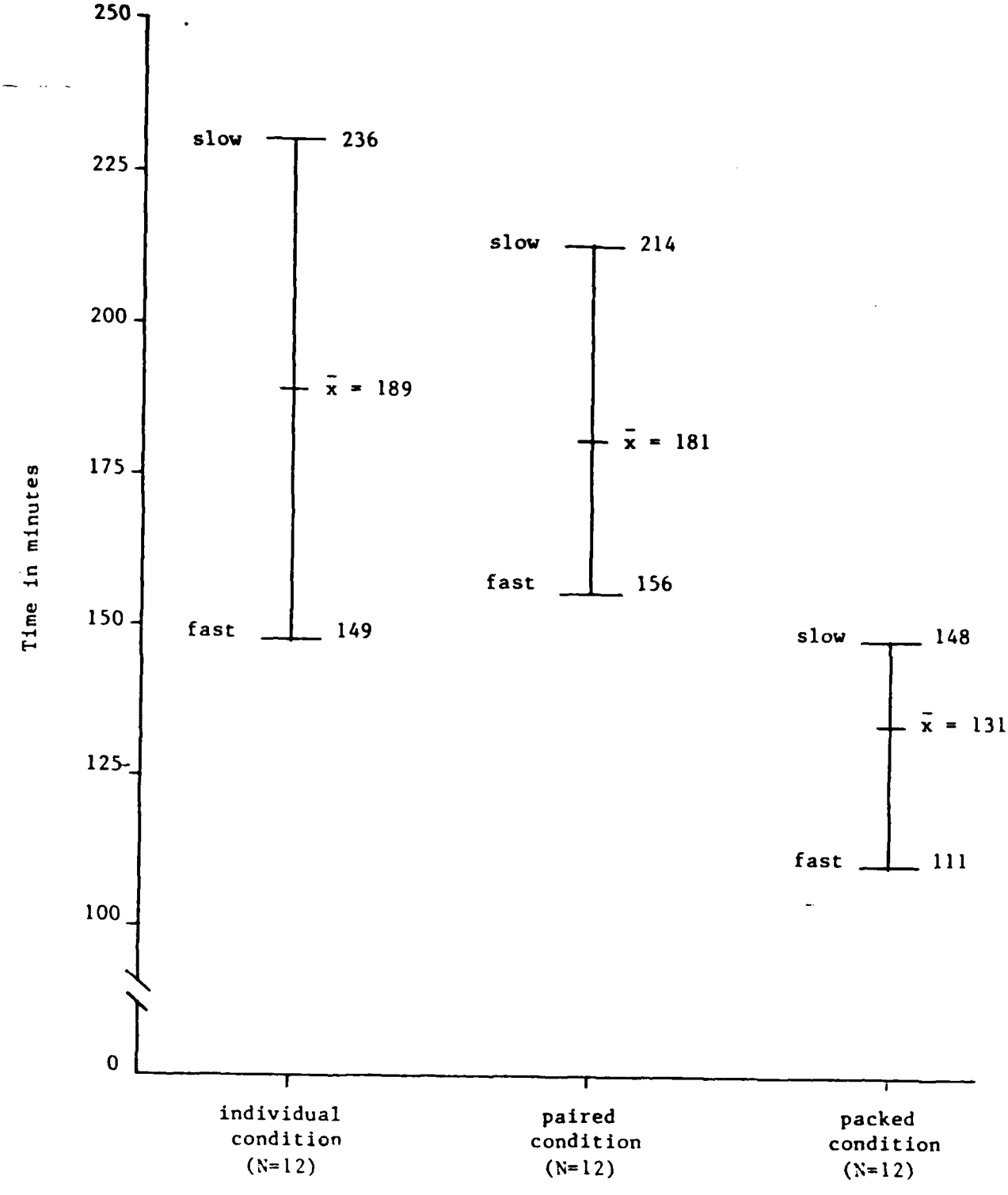

Figure 9. Study 2: Ranges of Time in Minutes to Complete Lessons by Research Conditions.

the pace of the more advanced students. However, an examination of the observers' comments indicated the same basic dynamics for most of the paired and packed groups. And, the only radical example of domination by a paired group member was when two low ability students were inadvertently paired. A corresponding explanation is that the slow students in the paired condition felt freer to discuss their problems than did their packed condition counterparts. Unfortunately, except for one extremely talkative paired group, the observers' comments did not provide any clear indications of "discussion differences" between these two conditions. Any advantages for pairing students at terminals versus a more packed situation (i.e., training slow ability students) could not be determined in this study. And, there might be some disadvantages (i.e., fewer students passing the test and slower completion times) of pairing students as compared to a more packed presentation mode.

This study's main findings have been that packed and paired CBI training seem to be preferable to individualized CBI training. However, there may be some problems with implementing packed or paired CBI training in the BNCOC curriculum. For instance, packed or paired CBI students -- free from any pressures inherent in a research study -- may not exhibit cooperative learning. A decision was thus made to examine the viability of having the BNCOC instructors implement these instructional strategies.

STUDY 3

Procedure

This study consisted of a validation trial in which the 19K BNCOC students took the CBI courseware as their military communications training. The BNCOC instructors implemented this courseware with only the following concessions to data collection: 1) administration of a pretest and biographical questionnaire and 2) observations of subjects' behaviors on the computer. Only one observer watched the entire class instead of an observer per terminal. This procedural change was done to limit any reactive effects due to outside intruders. Another change in this validation trial was the use of a new BNCOC performance test. This new performance test had to be used as it was mandated by the BNCOC program developers. Unfortunately, this new test was introduced just before the validation trial, which prohibited changing the pretest to match the posttest. Only qualitative comparisons between students' pretest and posttest performances can thus be made.

Eight students participated in this study with two or three students per terminal. These students were randomly assigned to the terminals. Again, three terminals were used in this study. The two students who passed the pretest were situated at different terminals. The background of these eight students was more similar to the background of the armor unit soldiers tested in the two previous studies, than to the background of the typical 19K BNCOC students. As shown in Table 5, five of these eight subjects had no previous experience with the CEOI and only two had any extended experience (more than a year) on tanks.

Table 5: Study 3: Demographic Results (n=8)

TYPE OF STUDENTS	19 BNCOC students
AVERAGE NUMBER OF YEARS IN PMOS	1.88
AVERAGE NUMBER OF YEARS ON TANKS	1.50
AVERAGE NUMBER OF YEARS AS TC	5.17
NUMBER OF Ss WITH PLDC EXPERIENCE	8
AVERAGE NUMBER OF YEARS OF TACTICAL TRAINING EXERCISES	.75
NUMBER OF Ss WITH CEOI EXPERIENCE	3
HIGHEST EDUCATIONAL LEVEL	
NON HIGH SCHOOL GRADUATES	0
GED	1
HIGH SCHOOL DIPLOMA	4
SOME COLLEGE	3
COLLEGE GRADUATES	0

Results and Discussion

As shown in Figures 10 and 11, this study's results compared favorably with those obtained in Studies 1 and 2. Only two students were able to pass the pretest while six received item-scores of less than 33%. Students' performance increased dramatically on the posttest as four achieved the criterion of ten points and six obtained item-scores of 80% of better. And these students took between 127 and 158 minutes to complete this courseware.

The following observations were made about the different groups. One group with three students did not have any problems in completing the courseware. These students needed instructor assistance only once. Responsibility for answering questions was shared equally among the members. One 19K BNCOC instructor spent some time passively observing the performance of this group.

The other group with three students had problems in completing this courseware. For one thing, the main 19K BNCOC instructor and another student spent considerable time trying to help a slow student with the material. Secondly, the third student, who received a passing pretest score, was bored

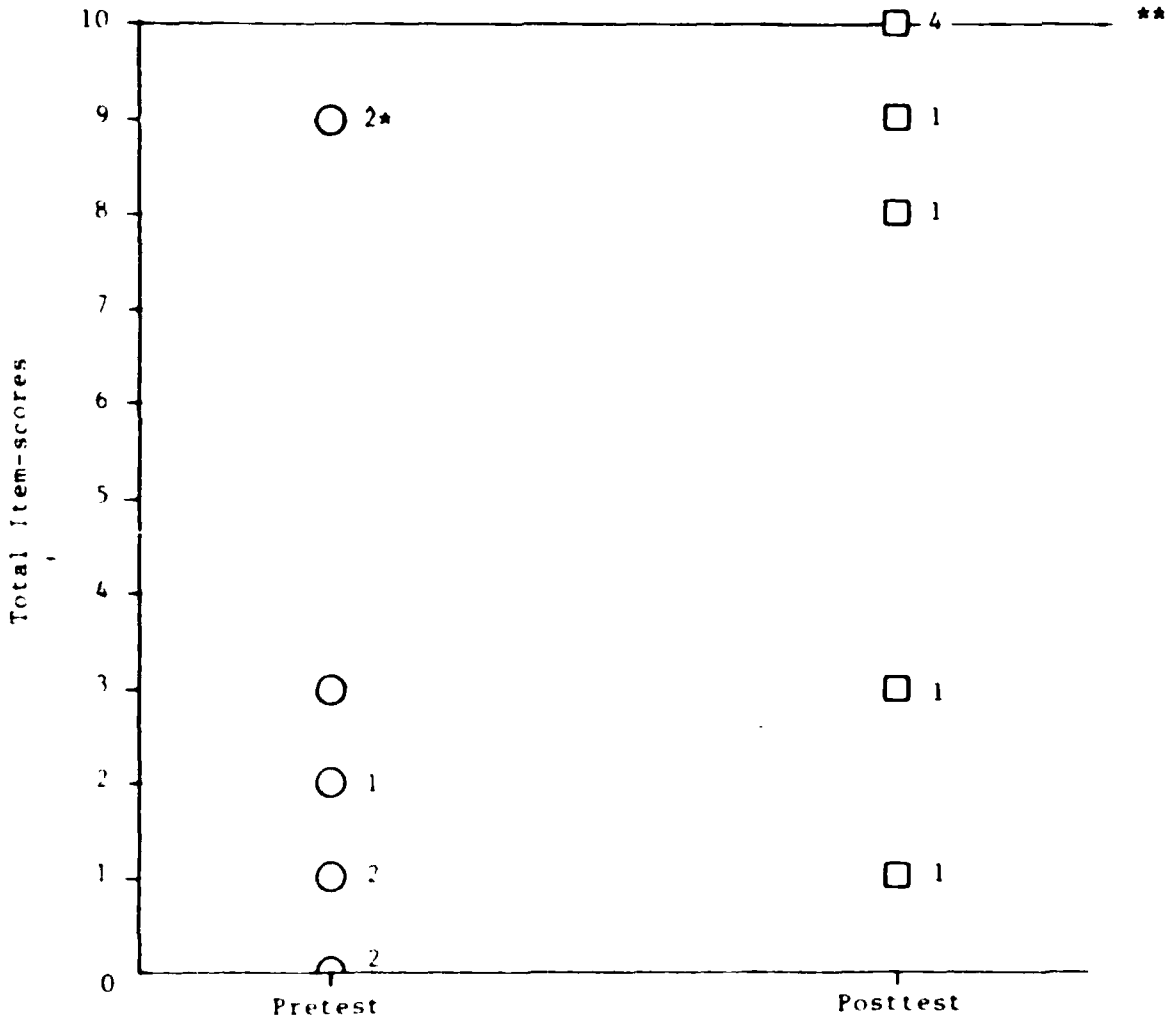

Figure 10. Study 3: Soldiers' Item-Scores on the Pretest and Posttest (N=8).

*All numbers by symbols represent frequency for each item-score.

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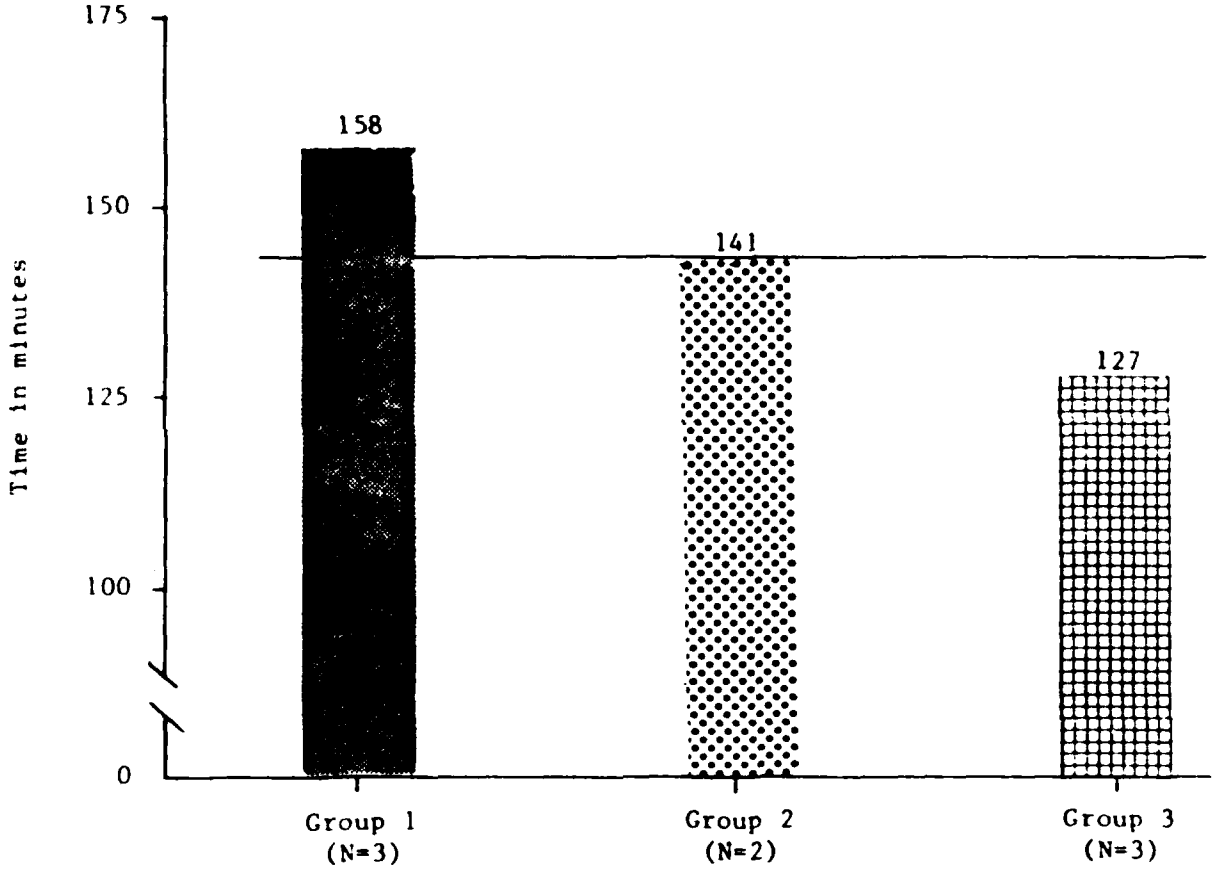

Figure 11. Study 3: Time in Minutes Per Group (N=8).

with this courseware. He would occasionally help the poor student and occasionally pay attention to other materials, e.g., a book on military communications.

The group with two students had minor difficulties in completing the task. They needed about the same amount of instructor assistance as did the paired groups in Study 2. However, one student wanted to dominate the other. The domineering student lectured to the other student about CEOI procedures and tried to control who would answer the questions. Even though these students never seemed to be compatible, they did eventually cooperate by sharing some of the responsibility for answering the questions.

Cooperative learning was thus exhibited in all three groups with most students having little need for instructor assistance. The one student who needed continuous instructor prompting was--according to the primary instructor--an unusually slow student. Also, more cooperative learning would have probably been exhibited by the high ability student if the instructor was not continuously present. The other high ability student did continuously help the other two members of his group.

This study's results thus have indicated that a successful implementation of this courseware and group CBI training in the 19K BNCOC curriculum is possible. Furthermore, both instructors seemed to be pleased with this courseware and method for presenting CBI materials, a situation which may be the best predictor of a successful implementation.

SUMMARY AND IMPLICATIONS

This investigation's data provided affirmative answers to the two basic hypotheses being examined. This CBI courseware seemed to be an effective course for training Military Communications in 19K BNCOC. Though practical constraints prevented direct comparisons with regular non-CBI instruction, there was some evidence suggesting that this CBI courseware is either more effective or just as effective as the conventional training methods. Subjects' posttest scores paralleled those found previously for regular instruction. This investigation's subjects took much less time to complete this courseware, including the time for the pretest and posttest, than they would have spent in the regular BNCOC class.

Secondly, this investigation's results indicated that group presentation of CBI materials could alleviate some of the major problems associated with using CBI as a primary instructional medium. Group presentation of CBI materials appeared to be more cost-efficient than individual CBI training. More students would be able to receive CBI training under group presentation with perhaps some increments in learning efficiency. The cost efficiency of group CBI training was further reinforced by the fact that the packed and paired condition student needed substantially less teacher guidance than did the individualized training condition students. Group CBI training could then help military institutions meet the current problem of dwindling instructional resources.

Group CBI learning could also help alleviate problems associated with typical CBI use by the more advanced students. Shlechter (in preparation) observed that individualized CBI training might be too confining for better students. However, this investigation showed that nearly all of the more advanced students became active participants in the group training condition. They were able to use their expertise to help follow classmates.

Also, packing several student at a terminal seems preferable to a paired presentation of CBI materials. Again, more students could be trained under the former condition with little learning decrements. These cited advantages for packed presentation (and paired vs. individual instructional modes) might be limited to certain types of courseware. For instance, packed CBI presentation might not be preferable for training in basic skills, e.g., reading.

Correspondingly, this investigation's results have indicated some potential problems with the packed and paired CBI modes of training. For one thing, packed or paired training might not be the optimal instructional modes for helping low ability students. Controversy, however, exists in the research literature about this relationship between low ability students and individualized training. Morrison (in preparation) has found that individualized training is better than peer-training for helping low ability students. Hagman and Rose (1983), however, have reported that low ability military trainees tend to benefit more from group-paced rather than from individualized instruction. Further research is thus needed before any firm conclusions can be reached about the most optimal CBI training mode for low ability students.

Another potential problem with grouped CBI training is that some students cannot work well with other students or with certain students. This latter problem might be easily resolved by having the group's membership structured by the instructor(s). But having formed the groups, the instructor should refrain from unduly interfering with the group's progress. For example, The instructor in Study 3 should have allowed the high ability student to serve as a peer instructor.

In closing, the following implications can be drawn from this study's findings:

(1) This CBI courseware seems to be appropriate for training Military Communications in 19K BNCOC.

(2) Packed and paired CBI training modes seem to be preferable to individualized CBI training for presenting this courseware.

(3) Packed CBI training is somewhat preferable to paired CBI training.

(4) Instructors may have to structure the membership of the packed and paired groups.

(5) Instructors should refrain from unduly interfering with a group's progress, but should be available when the group requests assistance.

(6) The potential disadvantages of using packed or paired CBI training for helping low ability students must be more carefully examined.

(7) Future research is also needed to determine the generalizability of this study's findings to other military courseware.

REFERENCES

Avner, R. A. (1982, February). Cost and planning estimates for PLATO CBE operations (CERL Report). Urbana, IL: University of Illinois Computer-Education Research Laboratory.

Clark, R. E. (1985). Confounding in educational computing research. Journal of Educational Computing Research, 1, 389-394.

Clark, R. E., & Leonard, S. (1985, March). Computer research confounding. Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Dickson, W. P., & Vereen, M. A. (1983). Two students at one terminal. Theory into Practice, 22(4), 296-300.

Dorsett, D. L., & Hulverson, P. (1983). Increasing technical training efficiency: Peer training via computer-assisted instruction. Journal of Applied Psychology, 68, 552-558.

Graham, S. E., Shlechter, T. M., & Goldberg, S. L. (1986). A preliminary evaluation of a model maintenance training program for Reserve Component Units. (ARI Research Report 1421). Fort Knox, KY: Fort Knox Field Unit, US Army Research Institute for the Behavioral and Social Sciences. (AD A173 909)

Hagman, J. D., & Hayes, J. F. (1986). Cooperative learning: Effects of task, reward, and group size on individual achievement. (ARI Technical Report 704). Alexandria, VA: US Army Research Institute for the Behavioral and Social Sciences. (AD A173 828)

Hagman, J. D., & Rose, A. M. (1983). Retention of military tasks: A review. Human Factors, 25(2), 199-213.

Morrison, J. E. (in preparation). Group learning methods for computer-based training, (ARI Research Note). Fort Knox, KY: Fort Knox Field Unit, US Army Research Institute for the Behavioral and Social Sciences.

Okey, J. R., & Majer, K. (1976). Individual and small-group learning with computer-assisted learning. Audio-Visual Communications Review, 24(1), 79-86.

Orlansky, J. (1985). The cost-effectiveness of military training. Proceeding of the symposium on the military value and cost-effectiveness of training (pp. 1-17). Brussels, Belgium: NATO.

Shlechter, T. M. (in preparation). An examination of the research evidence for computer-based instruction. In R. T. Hartson and D. Hix (Eds.). Advances in human-computer interactions, Volume 2. Norwood, NJ: Ablex Publishing Corporation.

Shlechter, T. M., & Anderson, M. (1986, July). (Comparability of CEOI evaluation instruments). Unpublished data. Fort Knox, KY: Fort Knox Field Unit, US Army Research Institute for the Behavioral and Social Sciences.

Sutter, E. G., & Reid, J. R. (1969). Learner variables and interpersonal conditions in computer-assisted instruction. Journal of Educational Psychology, 60, 153-157.

Trowbridge, D., & Durnin, R. (1984). Results from an investigation of groups working together at the computer, (Research Report). Washington, DC: National Science Foundation. (ERIC Document Reproduction Service No. ED 174-238.)

Wilson, L. S. (1984). Presenting TICCIT: State of the art computer-based instruction. Training Technology Journal, 1(2), 26-32.

APPENDIX A

STATISTICAL ANALYSES FOR STUDY 1

1. Chi-square analyses were calculated to determine the existence of significant differences between conditions in the percentages of students passing the pretest and posttest. A significant difference was found between conditions with regards to the posttest scores, X^2 (1, N=25 = 6.24; $p < .05$.)

2. Chi-square analyses were also calculated to determine the existence of any significant relationships between demographic variables and the percentage of students passing the pretests and posttests. A significant relationship existed only between posttest GO-rates and previous CEOI use X^2 (1, N=25) = 5.21; $p < .05$.

3. A 2 x 2 repeated measure ANOVA with two groups (packed and individualized) and two levels of test (pretest and posttest) was calculated to analyze the item-score data. Repetition occurred across the test variable. This ANOVA analysis was calculated by SPSS-X, subprogram MANOVA. The following source table was computed for this analysis:

Source	df	MS	F
GROUP	1	38.64	8.44*
ERROR (Bet)	23	4.57	
TEST	1	60.51	23.21*
GROUPS by TESTS	1	.03	.01
ERROR (Wit)	23	2.61	

*p<.05

4. A t-test was computed to analyze the subjects' time data. The following statistic was found: t(24) = .45; p>.05.

APPENDIX B

STATISTICAL ANALYSES FOR STUDY 2

1. Chi-square analyses were calculated to examine the soldiers' GO-rate data. These analyses involved the same variables as were discussed in Appendix A. A significant differences was found among the GO-rates for the different conditions X^2 (2, N=36), 8.00; $p < .05$.

2. A 3 x 2 repeated measure ANOVA with three groups (packed, paired and individualized) and two levels of test (pretest and posttest) was calculated. Repetition occurred across the test variable. This statistical analysis was computed by the computer program--SPSS-X, subprogram MANOVA. The following source table was computed for this analysis:

Source	df	MS	F
GROUP	2	1.64	.85
ERROR (Bet)	33	9.67	
TEST	1	174.22	43.80*
GROUPS by TESTS	2	.22	.06
ERROR (Wit)	33	3.98	

*p<.05

3. An one-way MANOVA was computed by using SPSS-X, subprogram. The predictor variable was groups (packed, paired, and individualized) and the criterion variables were: Time, Wrong Responses, Proctor (assistance), Need Help, and Gave Help. The computed Wilk's Lambda statistic revealed that significant effect(s) existed in the data (F=14.39; p<.05).

4. Follow-up univariable ANOVA analyses were then computed by the SPSS-X computer program. These ANOVAs revealed the following statistics:

VARIABLES	DF	MS*	ERROR MS*	F*
TIME	(2,33)	11712.44	619.27	18.91**
PROCTOR	(2,33)	301.36	13.13	22.96**
WRONG RESPONSES	(2,33)	752.03	41.02	18.33**
NEED HELP	(2,33)	206.58	32.41	6.37**
GAVE HELP	(2,33)	204.53	16.88	12.11**

*Values have been rounded-up
**p<.05

5. The following critical values were then calculated for the follow-up Scheffè t-tests:

VARIABLES	CRITICAL VALUES	$\bar{X}$ PACKED	$\bar{X}$ PAIRED	$\bar{X}$ INDIVIDUAL
TIME	25.53	131.67	181.33	189.33
PROCTOR ASSISTANCE	3.29	0.00	2.25	9.58
WRONG RESPONSES	6.57	4.17	8.42	19.50
NEED HELP	5.80	3.66	11.33	10.25
GAVE HELP	4.22	4.41	8.25	0.00